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(54) [Title of the Invention] STACKED-TYPE HEAT EXCHANGER

(57) [Abstract]

[AIM] To reduce the number of parts and reduce time and effort involved in managing parts. To enable the easy manufacture of a lightweight heat transmission tube unit.

[CONSTITUTION] Metal plates 39, 39 constitute a fluid passage 36. A pair of metal plates 39, 39 are joined so that their respective recessed parts 40, 40 face each other, thus forming a space therebetween, and joining parts 43, 43 are joined together in a fluid-tight manner, thus forming a tube element 37. An inner fin 38 has a corrugated cross-section. In addition, in the center thereof, there is formed a projecting wall part 45 that comes in contact with the recessed part 40 of one of the metal plates 39. The tube element 37 and inner fin 38 constitute a heat transmission tube unit 33. A number of heat transmission tube units 33 are stacked with an outer fin interposed therebetween.

[Claim 1] A stacked-type heat exchanger constituted by the stacking of a number of heat transmission tube units comprising a tube element having a U-shaped fluid passage one end of which is the fluid passage inlet and the other end of which is the fluid passage outlet and an inner fin disposed within said fluid passage so as to disrupt the flow of fluid through this fluid passage, said heat transmission tube units that adjoin each other having an outer fin interposed therebetween, wherein:

said tube element is constituted by the joining together of a pair of metal plates, each comprising a recessed part formed on one side that serves as fluid passage, first and second small recessed parts that serve as said fluid passage inlet and fluid passage outlet on one end of said recessed part, and a joining part that comprises an outer periphery with the exception of the end having these first and second small recessed parts; said joining together to be in a manner that recessed parts of the respective plates oppose each other and that the respective joining parts are joined in a fluid-tight manner;

said inner fin has a corrugated shape with a cross-section such that a plurality of indentations and projections are formed on both front and back sides; and has a projecting wall part continuing from one end of said recessed part but not reaching the other, so as to form said U-shaped fluid passage together with said recessed part, and extending from the bottom of a recessed part of one of said pair of metal plates to the bottom of a recessed part in the other; and

on at least either the inner surfaces of said pair of metal plates or the front and back surfaces of said inner fin, a layer of brazing filler material has been placed.

[Detailed Description of the Invention]

[0001]
[Technical Field of the Invention] The stacked type heat exchanger in accordance with the present invention is used, for example, as an evaporator for cooling air incorporated into an automobile's air conditioning device.
[0002]
[Background Art] Incorporated into air conditioning devices are evaporators that evaporate a cooling medium within, cooling the air circulating on the outside. Conventionally, stacked-type heat exchangers as shown in Figs. 9 and 10 have been used as heat exchangers that serve as such kind of evaporator. Fig. 9 shows a tank-integrated stacked-type heat exchanger. Fig. 10 shows a tank-separate stacked-type heat exchanger. Both types of stacked-type heat exchangers are made by assembling members made of an aluminum alloy material. We will briefly consider these two types of stacked-type heat exchangers.
[0003] The tank-integrated stacked-type heat exchanger shown in Fig. 9 is constituted by stacking a plurality of heat transmission tube units 1, 1 on top of each other. The heat transmission tubes 1, 1 are constituted by joining two metal plates 2, 2 so that a space is formed therebetween and then joining them to be fluid-tight. This metal plate 2, as shown in Figs. 11 and 12, has a flat part 3 that surrounds the entire perimeter, a shallow first recessed part 4 formed in a U-shape on the inside of this flat part 3, deep second and third recessed parts 5 and 6 on both ends of this first recessed part 4, and through holes 7 and 8 formed in the center of the second and third recessed parts 5 and 6.

[0004] In the plurality of heat transmission tube units 1, 1 that constitute a stacked-type heat exchanger for a tank-integrated, the U-shaped part formed by the first recessed part 4 serves as the flat tube 9 where fluid flows, and the parts formed by the second and third recessed parts 5 and 6 serve as parts of the inlet-side tank or the outlet-side tank. These heat transmission tube units 1, 1, as shown in Fig. 9, are stacked by butt joining the outer surfaces of the second and third recessed parts 5 and 6 of the metal plates 2, 2 constituting the heat transmission tube units 1, 1. An inlet tube 10 is connected to one of the pair of spaces formed by the second and third recessed parts 5 and 6, and an outlet tube 11 is connected to the other space.
[0005] With a plurality of stacked-type heat exchanger thus stacked, outer fins such as Colgate fins 31, 31 are sandwiched between adjoining flat tubes 9, 9 of adjoining heat transmission tube units 1, 1 and serve as the core part, and function so that good heat exchange takes place between the air, etc., flowing between adjoining flat tubes 9, 9 and the cooling medium or the like flowing within each flat tube 9.
[0006] The tank-separate type stacked-type heat exchanger as shown in Fig. 10, as with the tank-integrated type stacked-type heat exchanger described above, is constituted by stacking on top of each other a plurality of heat transmission tube units 1a, 1a. The heat transmission tube units 1, 1 are constituted by joining together two metal plates 2a, 2a (Fig. 13) so that a space is formed therebetween and then further joining them to be fluid-tight. As shown in Fig. 13, this metal plate 2a has formed on one end thereof a pair of projections 12, 13 with a space therebetween, and has formed on one surface thereof a U-shaped recessed part 14; the two ends of this recessed part 14 extend respectively until the ends of the pair of projections 13, 14.
[0007] In the case of a tank-separate stacked-type heat exchanger made using such metal sheets 2a, two of such metal sheets 2a, 2a form one set, and are joined so that their respective recessed parts 14, 14 face each other and a space is thus formed therebetween, and then are joined together so as to be fluid-tight, thus making a heat transmission tube unit 1a having a U-shaped bending back passage 15 and a pair of joining parts 16, 17 disposed on both ends of the bending back passage 15 and extending out from the edge thereof.
[0008] The respective joining parts 16, 17 of the plurality of heat transmission tube units 1a, 1a are inserted into slit-shaped connection holes 20, 20 formed on the respective side surfaces of first and second tanks 18, 19, and the outer peripheral surface of the joining parts 16, 17 are braze-joined in a fluid-tight manner to the inner peripheral surface of the connection holes 20, 20. The tanks 18, 19 are constituted by assembling a seat plate 21 as shown in Fig. 13 and a tank main body 22 and braze-joining them in a fluid-tight manner. The connection holes 20, 20 are formed on the bottom surface of the seat plate 21. In addition, outer fin such as Colgate fins 31, 31 are provided between adjoining heat transmission tube units 1a, 1a to constitute a core part.
[0009] In the cases shown in the figures, the inside of the first tank 18 is divided by a partitioning wall 32. This divides the inside of the first tank 18 into an inlet chamber 23 and an outlet chamber 24. A fluid feed port 25 is formed on the inlet chamber 23 side and a fluid take out port 26 is formed on the outlet chamber 24. Such a constitution allows the fluid passage of a fluid such as a cooling medium to be extended, leading to an improvement in heat exchange efficiency.

[0010] Although not shown in the figures, in stacked-type heat exchangers as described above, multiple projections are provided on the first recessed part 4 and the recessed part 14, or else inner fins are provided, in order to disrupt the flow of cooling medium or other fluid, thus improving heat exchange efficiency. For example, Japanese Laid-open Patent Examination 4-155191, A, Laid-open Utility Model Application 2-69289, U, and Laid-open Utility Model Application 4-17263, U all describe a stacked-type heat exchanger with such an inner fin. Of these documents, Japanese Laid-open Patent Examination 4-155191, A discloses art relating to a tank-integrated stacked-type heat exchanger having an inner fin, as shown in Figs. 14 to 17. Figs. 14 and 15 show a first example, and Figs. 16 and 17 show a second example.

[0011] In the first example shown in Figs. 14 and 15, in the center of the first recessed part 4 formed on the metal plate 1b, a projecting wall 27 is provided that is slightly shorter than the length of this first recessed part 4. On the parts 28a to 28c present around this projecting wall 27 are disposed inner fins 29a to 29c, which are formed so as to virtually conform in shape to the parts 28a to 28c. These inner fins 29a to 29c have multiple projections and indentations alternatingly formed thereupon. Providing such inner fins 29a to 29c increases heat exchange efficiency by disrupting the flow of a fluid such as a cooling medium passing through a stacked-type heat exchanger when stacked-type heat exchangers constituted by a plurality of metal plates 1b and inner fins 29a to 29c are used.

[0012] In the constitution of the second example, shown in Figs. 16 and 17, two inner fins 30, 30 are provided, one on each side of a projecting wall 27a. The remainder of the constitution is the same as with the first example. As with the constitution of the first example, in the constitution of this second example, too, the inner fins 30, 30 cause disruption of the flow of a fluid such as a cooling medium flowing in a stacked-type heat exchanger, thus improving heat exchange efficiency.

[0013]

[Problems the Invention Aims to Solve] However, stacked-type heat exchangers having the above-described inner fins had the following problems which arose because of the inner fins. As described above, in a stacked-type heat exchanger having inner fins, giving a fluid passage a U-shape makes this fluid passage longer; the aim is improved heat exchange efficiency. In order to construct such a U-shaped fluid passage and provide an inner fin in this fluid passage, this inner fin has to be divided into a plurality of parts (in the examples shown in the figures, two or three parts). Furthermore, in order to form such a U-shaped fluid passage, projecting walls 27, 27a have to be formed in the center part of each metal 2, 2a in order to form the fluid passage. As a result, there is an increase in the number of constitutional parts constituting a stacked-type heat exchanger, and the management of all these parts is troublesome. Moreover, the greater the number of parts, the more complicated manufacturing becomes. In addition, forming projecting walls 27, 27a, causes the metal of the metal plates 2, 2a to be pulled with the formation of the projecting walls 27, 27a, and thus a sufficient thickness must be given to the metal plates 2, 2a, resulting in increased material cost and weight.

[0014] Japanese Laid-open Patent Application 62-202999, A, discloses a stacked-type heat exchanger having inner fins, as shown in Fig. 18, that does not have a projecting wall. In the heat exchanger disclosed in this document, there is no pulling of the metal caused by formation of a projecting wall; however, the cooling medium fluid passage of

this heat exchanger extends only from the one end of the metal plate 2 on which through holes 7a, 7a are provided as cooling medium inlets (upper left end in Fig. 18) to the other end of metal plate 2, on which through holes 8a, 8a have been provided as cooling medium outlets (lower right in Fig. 18). Therefore, in comparison to a stacked-type heat exchanger provided with a U-shaped fluid passage as described above, the heat exchange efficiency suffers.

[0015] The stacked-type heat exchanger according to the present invention was conceived in order to provide a stacked-type heat exchanger that solves the above-described problems, has few parts, can be easily manufactured, is lightweight and has excellent heat exchange properties.

[0016]

[Means for Solving the Problems] The stacked-type heat exchanger according to the present invention is constituted, as with the above-described conventional stacked-type heat exchangers, by stacking a number of heat transmission pipe units having a tube element having a U-shaped fluid passage one end of which is the passage inlet and the other end of which is the fluid outlet and a heat transmission tube unit provided with an inner fin disposed within the fluid passage so as to disrupt the flow of the fluid flowing in this fluid passage; adjoining heat transmission tube units have outer fins disposed therebetween.

[0017] Specifically, in the stacked-type heat exchanger according to the present invention, the tube element is constituted by a pair of metal plates each provided with a recessed part formed on one side thereof that serves as fluid passage, first and second small recessed parts formed on one end of the recessed part and serving as fluid passage inlet and fluid passage outlet, and a joining part constituted by an outer periphery edge part that excludes the end that has these first and second small recessed parts; the metal plates are assembled together such that their respective recessed parts face each other, and respective joining parts in contact with each other are joined in a fluid-tight manner. The inner fin is corrugated in shape, and has a cross-sectional shape such that a plurality of indentations and projections are seen on both front and back surfaces. In addition, so as to form the recessed part and the U-shaped fluid passage, this inner fin forms a projecting wall part in the center of the fluid passage and continues from one end of the recessed part, without reaching the other end, and extends from the recessed part bottom surface of one metal plate to the recessed part bottom surface of the other. Further, brazing material is layered on at least the inner surface of the metal plate or the front and back surfaces of the inner fin.

[0018]

[Operations] When using a stacked-type heat exchanger according to the present invention as described above, the operations themselves for the exchange of heat between a fluid such as a cooling medium flowing through the inside and the air circulating on the outside is the same as for a conventional stacked-type heat exchanger as described above. In particular, in the stacked-type heat exchanger according to the present invention, because a projecting wall is not formed on the metal plate, there is no pulling of the metal, and the production of this metal plate is easy, with no need to make the metal plate particularly thick. In addition, because the heat transmission tube unit is formed from a pair of metal plates and one inner fin, the number of parts is small, and the amount of time and effort need for parts management is reduced.

[0019]
[Embodiments] Figs. 1 to 4 show an embodiment of the present invention as applied to a tank-separate type heat exchanger. A stacked-type heat exchanger according to the present invention is constituted by assembling members made from an aluminum alloy material, as with the above described conventional stacked-type heat exchangers; specifically, the heat transmission tube part is constituted by stacking multiple heat transmission pipe units 33 (Fig. 4). The heat transmission pipe unit 33 has a pipe element 37 having a U-shaped fluid passage 36 one end of which is a fluid passage inlet 34 and the other end of which is a fluid passage outlet 35, and an inner fin 38 disposed so as to disrupt the flow of cooling medium or other fluid flowing in the fluid passage 36.
[0020] The pipe element 37 has one set of two metal plates 39 as shown in Fig. 1; one plate is placed on top of the other so that the respective recessed parts face each other and the plates are braze-joined. The fluid-tightness of the butt-jointed parts is of course maintained. The metal plate 39 has a recessed part 40 formed on one side to serve as the fluid passage 36, first and second small recessed parts 41 and 42 formed on one end of the recessed part 40 (the upper end in Fig. 1) and serving as the fluid passage inlet 34 and fluid passage outlet 35, and a joining part 43 comprising the outer periphery edge with the exception of the end having the first and second small recessed parts 41 and 42.
[0021] The inner fin 38, as shown in Fig. 3, is formed so that its cross-sectional shape forms a wave pattern that is corrugated, with a plurality of indentations and projections formed on both front and rear surfaces. In addition, its outer periphery edge is a flat contact part 44 that comes in contact with the joining parts 43 of the metal plates 39. Further, a projecting wall part 45 is formed in the center of the recessed part 40, extending between the respective recessed parts of the pair of metal plates 30 [sic], so as to form U-shaped fluid passage 36 together with the recessed part 40 on the metal plate 39.
[0022] The tube element 37 and inner fin 38 thus constituted are brazed joined in such a state that, as shown in Fig. 3, joining parts 43, 43 formed respectively on a pair of metal plates 39, 39 sandwich the contact part 44 of the inner fin 38, thus forming one heat transmission tube unit 33. Inside this heat transmission tube unit 33, a U-shaped bending back fluid passage 36 is formed by the recessed part 40 and projecting wall part 45.
[0023] In order to perform the braze joining as described above, for example, a layer of braze filler material (aluminum alloy containing a lot of Si) is placed on both the inner and outer surfaces of the core material. In this case, the inner fin 38 and outer fin 39 remain just core material, and there is no need for a braze filler material layer. By providing a braze filler layer on the inner surface of the metal plate 39, the metal plate 39 and inner fin 38 can be brazed together. The reason for putting a braze filler layer on the outer surface of the metal plate 39 is to braze join the plate with the Colgate fin 31 or other outer fin. Because one inner fin 38 is braze joined to a pair of metal plates 39, 39 to form a heat transmission tube unit 39 and an outer fin is braze joined between adjoining heat transmission tube units 33, the possible combinations of the material constituting the metal plate 39, inner fin 38 and outer fin are as set forth below in items 1 to 4 of Table 1.
[0024]
[Table 1]

| | Metal Plate | Inner Fin | Outer Fin |
|---|---|---|---|
| 1 | Layer of braze filler | Core material only | Core material only |

| | | | |
|---|---|---|---|
| | material on both inside and outside surfaces of core material | | |
| 2 | Layer of braze filler material on outside surface of core material | Layer of braze filler material on both inside and outside surfaces of core material | Core material only |
| 3 | Layer of braze filler material on inside surface of core material | Core material only | Layer of braze filler material on both inside and outside surfaces of core material |
| 4 | Core material only | Layer of braze filler material on both inside and outside surfaces of core material | Layer of braze filler material on both inside and outside surfaces of core material |

[0025] The tube element 37 is constituted by the metal plates 39, 39, and the heat transmission tube unit 33 is constituted by this tube element 37 and inner fin 38. A number of these heat transmission tube units 33 are stacked with an outer fin interposed between adjoining heat transmission tube units 33. Further, as shown in Fig. 10, a pair of tanks are joined, the contact part is brazed, and the stacked-type heat exchanger is completed. With a stacked-type heat exchanger according to the present invention thus constituted, the operations themselves when, for example, heat is exchanged between a cooling medium flowing within and air circulating on the outside, are the same as with the above-described conventional stacked-type heat exchangers.

[0026] Particularly because no projecting wall is formed on the metal plate in the stacked-type heat exchanger according to the present invention, the metal of the metal plate will not be pulled, and a thin metal plate can be used. In addition, because the heat transmission tube unit 33 is constituted by a pair of metal plates 39, 39 and an inner fin 38, the number of parts is small, so less time and effort is needed for managing parts.

[0027] It should be noted that in the above embodiment, the inner fin 38 is given the shape of a sine curve, as shown in Fig. 3; alternatively, it may be shaped, as shown in Fig. 5, with indentations and projections alternating, and the phase of these indentations and projections shifted in the vertical direction. In addition, as shown in Fig. 6, the inner fin may be constituted to have corrugations with multiple holes 46, 46 provided on the corrugations. Any position and any size for these holes 46, 46 may be used. In addition, Fig. 6 shows an example in which the inner fin 38 shown in Fig. 5 has been given holes 46, 46; holes may be given to the inner fin 38 shown in Fig. 4 or to an inner fin with any other shape, as well. In no case, however, can a hole be given to the projecting wall part 45.

[0028] Further, Figs. 7 and 8 show a stacked-type heat exchanger with a U-shaped fluid passage 36 in which the width of the fluid passage at the outlet side (left in Fig. 7) is larger than the width of the fluid passage at the inlet side (right in Fig. 7). Such a heat exchanger is used in cases where the cooling capacity of an air conditioner is to be increased by increasing the surface area of the heat exchanger. When applying the present invention to such a heat exchanger, as described above, a recessed part 40 and first and

second small recessed parts 41 and 42 are formed on the pair of metal plates 39. Further, for the inner fin 38, as shown in Fig. 8, the position where the projecting wall part 45 is formed is shifted in one direction (to the right in Fig. 8) so that the part facing the outlet part at which a fluid such as a cooling medium flows out is wider than the part facing the inlet part at which a cooling medium flows in. Otherwise the constitution, as well as the operations, is the same as in the previous example. It should be noted that in Fig. 8 the corrugation shape is the same as in Fig. 3, but of course shapes as shown in Figs. 5 and 6 may also be used.

[0029] For the embodiments described above, explanations were given for examples in which the contact part of the inner fin was sandwiched by the joining parts of a pair of metal plates, but the present invention is not limited to such a constitution. For example, a constitution may be used such that the joining parts are eliminated, and the inner surfaces of a pair of metal plates and the top of the indentations and projections of the inner fin are braze-joined. In addition, in the above-described embodiments, an explanation was given of an example in which the present invention was applied to a tank-separate stacked-type heat exchanger; however, the present invention may also be applied to a tank-integrated stacked-type heat exchanger. In addition, in place of the pair of metal plates 39, 39 constituting the tube element 37, a recessed part and small recessed parts can be formed on both halves of a single metal plate; after this metal plate is folded along its center, it is braze-joined, thus constituting a tube element. In addition, in the case of a tank-separate stacked-type heat exchanger as shown in Fig. 1, as in the conventional example shown in Fig. 10, a partitioning wall 32 may be provided in a first tank 18, and the fluid passage for a fluid such as a cooling medium can be made longer, so as to improve heat exchange efficiency. Further, the corrugations provided on an inner fin to disrupt the flow of a fluid such as a cooling medium are not limited to a continuous embankment-shape but may, for example, be formed so that spherical projections alternate on the front and rear sides.

[0030]

[Effect of the Invention] The stacked-type heat exchanger according to the present invention, because it is constituted and operated in the manner described above, has few parts, resulting in less time and effort needed for manufacturing and managing parts. In addition, because the thickness of the metal plate is thin, cost for materials can be reduced as well as the weight. Furthermore, because the number of parts is small, the assembly process is simple.

[Brief Description of the Drawings]

Fig. 1 shows a metal plate constituting a stacked-type heat exchanger according to the present invention; (A) is a plan view and (B) is a side view.

Fig. 2 shows an inner fin constituting a stacked-type heat exchanger according to the present invention; (A) is a plan view and (B) is a side view.

Fig. 3 is a cross-sectional view of a heat transmission tube unit.

Fig. 4 is a side view of a heat transmission tube unit.

Fig. 5 is a partial end view showing a first example of a specific shape of an inner fin.

Fig. 6 is a partial cross-sectional view of a heat transmission tube unit showing a second example.

Fig. 7 is a cross-section showing an example in which the present invention has been applied to a different stacked-type heat exchanger.

Fig. 8 is an end view of an inner fin used in this stacked-type heat exchanger.

Fig. 9 is a front view showing a first example of a conventional stacked-type heat exchanger.
Fig. 10 is an oblique view showing a second example of a conventional stacked-type heat exchanger.
Fig. 11 is a plan view showing a metal plate constituting the first example of a stacked-type heat exchanger.
Fig. 12 is a cross-section along the line X-X in Fig. 11.
Fig. 13 is a partial oblique view of a metal plate and tank constituting the second example of a stacked-type heat exchanger.
Fig. 14 is a front view showing the first example of a metal plate and inner fin constituting a stacked-type heat exchanger.
Fig. 15 is an oblique view of an inner fin of the first example.
Fig. 16 is an oblique view showing a second example of a metal plate constituting a stacked-type heat exchanger.
Fig. 17 is an oblique view showing a second example of an inner fin constituting a stacked-type heat exchanger.
Fig. 18 is an exploded oblique view shown another example of a heat transmission tube unit constituting a stacked-type heat exchanger.
[Explanation of the Indicators]
1, 1a, 1b: heat transmission tube unit
2, 2a: metal plate
3: flat part
4, 4a, 4b: first recessed part
5: second recessed part
6: third recessed part
7, 7a, 8, 8a: through hole
9: flat tube
10: inlet tube
11: outlet tube
12, 13: projections
14: recessed part
15: bending back fluid passage
16, 17: joining part
18: first tank
19: second tank
20: connection hole
21: seat plate
22: tank main body
23: inlet chamber
24: outlet chamber
25: fluid feed port
26: fluid take-out port
27, 27a: projecting wall
28a, 28b, 28c: parts
29a, 29b, 29c: inner fins
31: Colgate fin

32: partitioning wall
33: heat transmission tube unit
34: fluid passage inlet
35: fluid passage outlet
36: fluid passage
37: tube element
38: inner fin
39: metal plate
40: recessed part
41: first small recessed part
42: second small recessed part
43: joining part
44: contact part
45: projecting wall part
46: hole

[see original for figures]